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Studies on Copper Molybdate as Humidity

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ABSTRACT

In this attempt copper molybdate is used as humidity sensor. It is synthesized by solution method. Using electronic sensor kit output voltages are measured for different output voltages are measured for different percentage of humidity. Standardization of the electronic sensor kit is done using known values of Rh. Copper molybdate behaves as a good humidity sensor at all levels and the results of this compound as humidity sensor are presented and discussed in this paper.

Keywords: Humidity sensor, Copper molybdate

INTRODUCTION

In agriculture and climatology humidity measurement is the most essential thing. In high-speed, low-power and low-cost microelectronic hybrid circuits [1-4], modern signal conditioning methods [5,6] and advances in miniaturization technologies [7-11] sensors techniques are used. The diagnosis of corrosion and erosion in advanced batteries, like lithium batteries, are among the applications of humidity sensors. For physical comfort monitoring and controlling environmental humidity is receiving ever-wider attention [6].

The application of humidity sensors are presented in Table 1. The choice of the material was made on the basis of their humidity, temperature, low hysteresis and stability with respect to ageing and thermal cycling.

The three main classification of humidity sensors are: electrolytes, organic polymers and ceramics [11]. The electrolyte-based humidity sensors employing LiCl, developed by Dunmore et al. was used for over 40 years, which was the only electrical device then available for moisture sensing. However, this sensor showed rather low response time, and was unable to function in highly humid environment as well as those bearing ammonia or organic vapours. Other materials were thus studied for use in those environments where LiCl-sensor was not suitable [12]. Polymer films could not operate at higher temperature/humidity besides exhibiting hysteresis, slow response time, long-term drift, and degradation upon exposure either to solvent vapor or to electrical shocks. They also required independent temperature compensation. In research on this subject have resulted in notable improvement in this characteristic [13,14]. Amongst these, polymeric capacitive sensors had proved to be moderate commercial success [15].

A few ceramic materials possess a unique structure consisting of grains, grain boundaries, surfaces and pores, which make them amenable for chemical sensing [16-18]. The processing techniques had paved way to modify the stages of ceramic production such that the desired microstructure of the compacts could be tailor-made. The ceramic materials permit both performance optimizations exploiting electrical properties [19]. The humidity sensing ceramics had to be heat cleaned to ensure reversibility. The prolonged exposure to humid environments lead to the gradual formation of stable chemisorbed OH^- on the surface, causing a progressive drift in the resistance of the ceramic humidity sensor.

The impurities get adsorbed like water molecules and are removed through heat cleaning. Various humidity-sensing mechanisms and operating principles had been identified for ceramics [20]. Among the other sensors, the ones based on the solid-electrolyte type, employ the hetero-contacts between p-and n-type semi conducting oxides [21,22].

MATERIALS AND METHODS

All the reagents employed for the syntheses were of pure grade and in most cases the following chemicals are used:

Copper Sulphate ($CuSO_4$), Copper Oxide (CuO), Ammonium Molybtate, acetone, Potassium acetate (CH_3COOK), Sodium Nitrite ($NaNO_2$), Barium Chloride ($BaCl_2$), and Copper Sulphate Pent hydrate ($CuSO_4.5H_2O$) are the chemicals required. We used this pellet for the humidity studies.

Preparation of copper molybdate (solution method)

The salts, Copper Sulphate Pentahydrate (mole wt=249.68 g) and Ammonium Hepta Molybdate (mole wt=1235.86 g) taken in equimolar ratio (1:1) are dissolved in water separately and these two solutions are mixed with constant stirring at room temperature. The mixture is digested on a water bath for 30 min and tested for complete precipitation. The precipitate is allowed to settle for a 1 h. Glass crucibile is used to collect the precipitate. It is washed with cold water until the washings are free from Chloride ions. It is then dried in the oven at 200°C for 3 h.

Humidity sensing studies: This is done as follows

i) Output voltages are measured for different percentage of humidity, using electronic sensor kit.
ii) Standardization of the electronic sensor kit for humidity measurement.

By measuring output voltage using electronic sensor kit for different percentage of humidity

Our kit is used for measuring various humidity levels. An hydrous saturated aqueous solution of Potassium acetate (CH_3COOK), Sodium nitrite ($NaNO_2$), Barium Chloride ($BaCl_2$) and Copper Sulphate Pentahydrate ($CuSO_4.5\ H_2O$) are used in a desiccator at a temperature of 25ºC, which yielded approximately 22%, 51%, 79%, 98% relative humidity respectively.

The output voltage was measured for all the prepared samples CMCO-82, 64, 55, 46, 28, with an input from 200 mv–1200 mv are listed in Tables from Tables 1-6. The plots of input voltage (V_{in}) V_s output voltage (V_o) is linear as shown in the figures from Figures 1-4 and resistance are computed from the measured data.

Table 1: **CMCO-82, input voltage (v_{in}) vs output voltage (v_o) at 22% rh**

Input voltage v_{in} (mv)	Output voltage v_{out} (mv)
200	390
400	280
600	200
800	20
1000	-150
1200	-390

The plots of Input voltage v_s output voltage shows the linear form in the Figure 1.

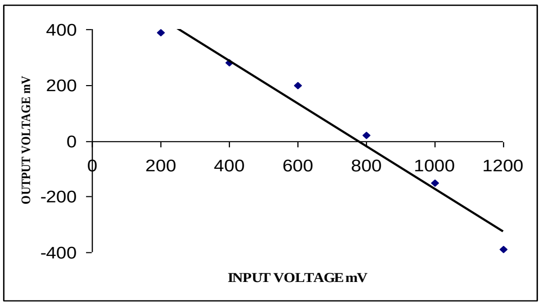

Figure 1: CMCO-82 plot of input voltage (v_{in}) vs output voltage (v_o) at 22% rh

Table 2: CMCO-82 input voltage (v_{in}) vs output voltage (v_o) at 51% rh

Input voltage V_{in} (mV)	Output voltage V_{out} (mV)
200	280
400	140
600	-20
800	-250
1000	-400
1200	-600

The plots of Input voltage V_s output voltage shows the linear form in the Figure 2.

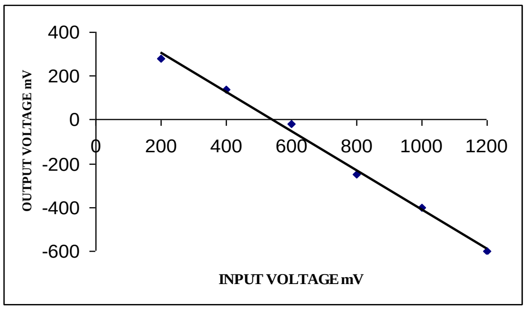

Figure 2: CMCO-82 plot of input voltage (V_{in}) Vs output voltage (V_o) at 51% rh

Table 3: CMCO–82 input voltage (V_{in}) Vs output voltage (V_o) at 79% Rh

Input voltage V_{in} (mV)	Output voltage V_{out} (mV)
200	-180
400	-270
600	-380
800	-480
1000	-580
1200	-710

The plots of Input voltage v_s output voltage shows the linear form in the Figure 3.

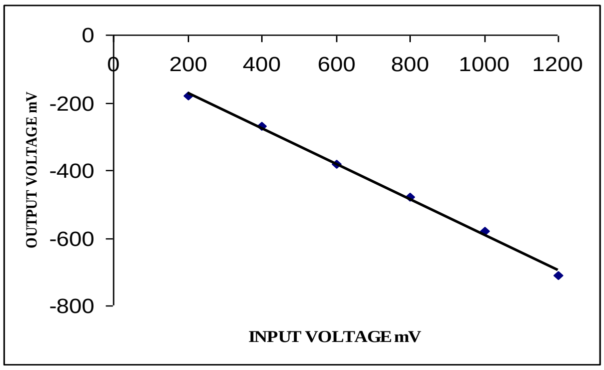

Figure 3: CMCO-82 plot of input voltage (V_{in}) vs output voltage (V_o) at 79%rh

Table 4: CMCO–82 input voltage (V_{in}) vs output voltage (V_o) at 98% rh

Input voltage vin (mv)	Output voltage Vout (mV)
200	-430
400	-480
600	-580
800	-670
1000	-800
1200	-930

The plots of Input voltage v_s output voltage shows linear form in the Figure 4.

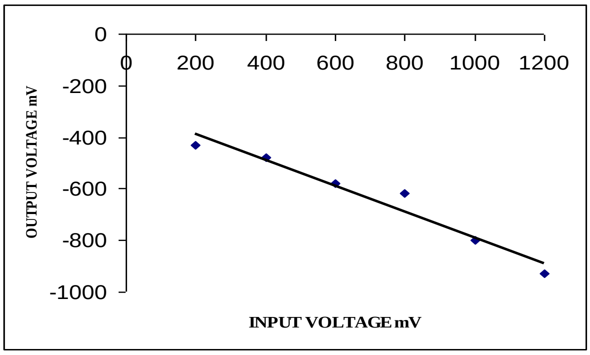

Figure 4: CMCO–82 plot of input voltage (v_{in}) Vs output voltage (V_O) at 98% RH

Table 5: CMCO-82 relative humidity Vs resistance

Relative Humidity (%RH)	Resistance MΩ
22	10
51	8.33
79	6
98	8.3

The composite CMCO–82 was kept at different relative humidity, output voltage was measured for given input voltage. The resistance of the pellet can be determined from the plot of V_{in} (input voltage) v_s V_{out} (output voltage) for the composite at different Relative Humidity. The linear graph is plotted in the Figure 5.

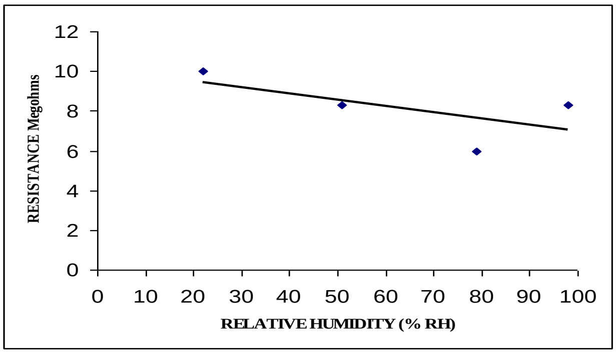

Figure 5: CMCO–82 plot of relative humidity vs. resistance

Table 6: CMCO–82 relative humidity vs. output voltage for various input voltage

Relative humidity (%RH)	Output voltage (mV)					
	V_{IN}=200 mV	V_{IN}=400 mV	V_{IN}=600 Mv	V_{IN}=800 mV	V_{IN}=1000 mV	V_{IN}=1200 mV
22	390	280	200	20	-150	-390
51	280	140	-20	-250	-400	-600
79	-180	-270	-380	-480	-580	-710
98	-430	-480	-580	-670	-800	-930

The Relative Humidity was varied and output voltage observed for six input voltages. The plot of Relative Humidity v_s Output Voltage using the Table 6 and Figure 6 shows that variation of output voltage with percentage of relative humidity is in linear trend.

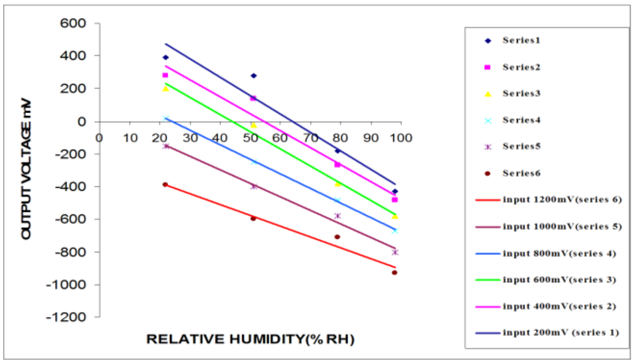

Figure 6: Output voltage with percentage of relative humidity

DISCUSSION

Thus the copper molybdate behaves as a humidity sensor. In the light of the aforementioned discussion it may be construed that at lower RH levels the conduction may be electronic, and at medium RH levels it may be due to both electronic and ionic and at RH levels it may be due to proton hopping between water molecules.

CONCLUSION

A simple device is possible to construct with Copper molybdate which will be useful as humidity sensor. This behaves as a useful material in almost all the Rh levels.

REFERENCES

[1] http://www.hygrometers.com/
[2] http://www.inapg.inra.frles-rech/siab/asteq/clba/introsen.html
[3] http://www.sensorland.com
[4] J.W. Schwant, M. Diabaltisa, MRS Bulletin, Publication of the Materials Research Society, **1999**, 24, 44.
[5] A.M. Edwin Suresh Raj, C. Mallika, O.M. Sreedharan, K.S. Nagaraj, *Materials Research Bulletin*, **2001**, 36, 832.
[6] B.M. Kulwicki, *J. Am. Ceram. Soc.*, **1991**, 74, 697.
[7] J.L. Deschanvres, P. Rey, G. Delabouglise, M. Labeau, J.C. Joubert, *Sensors and Actuators*, A 33, **1992**, 43.
[8] V. Matko, D. Donlagic, *Sensors and Actuators*, **1997**, A 61, 331.
[9] M. Mabrook, P. Hawkins, *Sensors and Actuators*, B 75, **2001**, 197
[10] Y.C. Yeh, T.Y. Tseng, D.A. Chang, *J. Am. Ceram. Soc.*, **1992**, 73, 1992.
[11] K. Miyazaki, C.N. Xu, M. Hieda, *Electrochem. Soc*., **1994**, 73, L35.

[12] T. Morimoto, M. Nagao, F. Tokuda, *J. Phys. Chem*., **1969**, 73, 243.
[13] K.S. Chou, T.K. Lee, F.J. Liu, *Sensors and Actuators,* **1999**, B 56, 106.
[14] S.A. Hashmi, *Solid State Ionics,* **1997**, 96, 209.
[15] M. Matsuguchi, Y. Sakoda, Y. Sakai, T. Kuroiwa, I. Ito, *J. Electrochem. Soc.*, **1991**, 138, 1862.
[16] A.M.E. Suresh Raj, C.M. Magadalane, K.S. Nagaraja, *Phys. Stat. Sol.,* **2002**, 191, 230.
[17] S. Pokhrel, K. S. Nagaraja, *Phys. Stat. Sol.,* **2002**, 194, 230.
[18] D.M. Dawson, G.S. Henshaw, D.E. Williams, *Sensors and Actuators,* **1995**, B 26-27, 76.
[19] E. Traversa, *Sensors and Actuators,* **1995**, B 23, 135.
[21] E. Traversa, A. Bearzotti, M. Miyayama, H. Yanagida, *Sensors and Actuators,* **1995**, B 24-25, 714.
[21] K. Hasumi, K. Nagano, S. Kamiyama, H. Yanagida, *US Patent No. 5618496*, **1997**.
[22] W. Qu, J. U. Meyer, *US Patent No.5969231*, **1999**.